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science for a changing world

USGS Earthquake Hazards Program

Earthquakes 101 (EQ101)

Lisa Wald
USGS Pasadena

U.S. Department of the Interior
U.S. Geological Survey

Global Distribution of Earthquakes

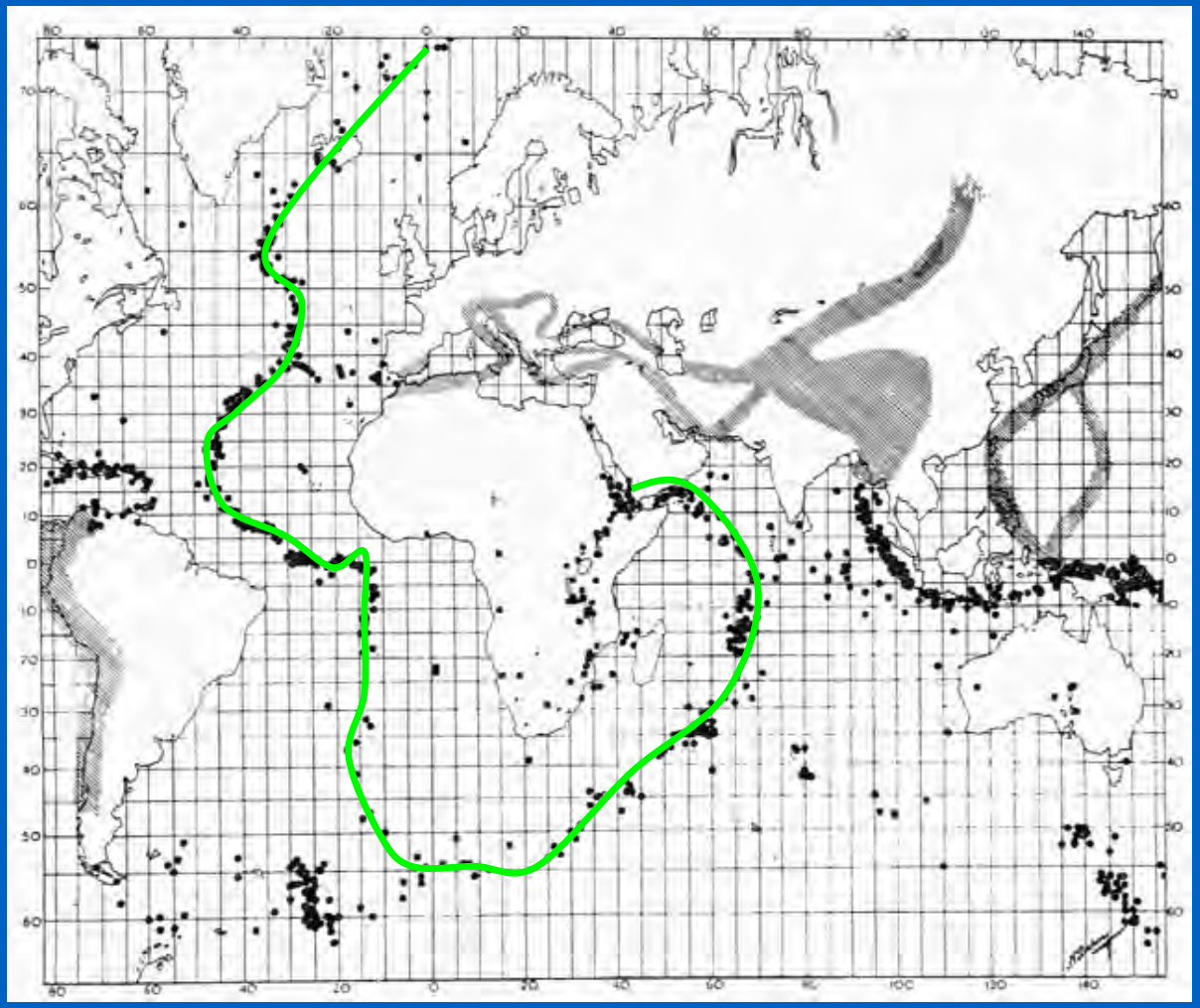

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Plate Tectonics

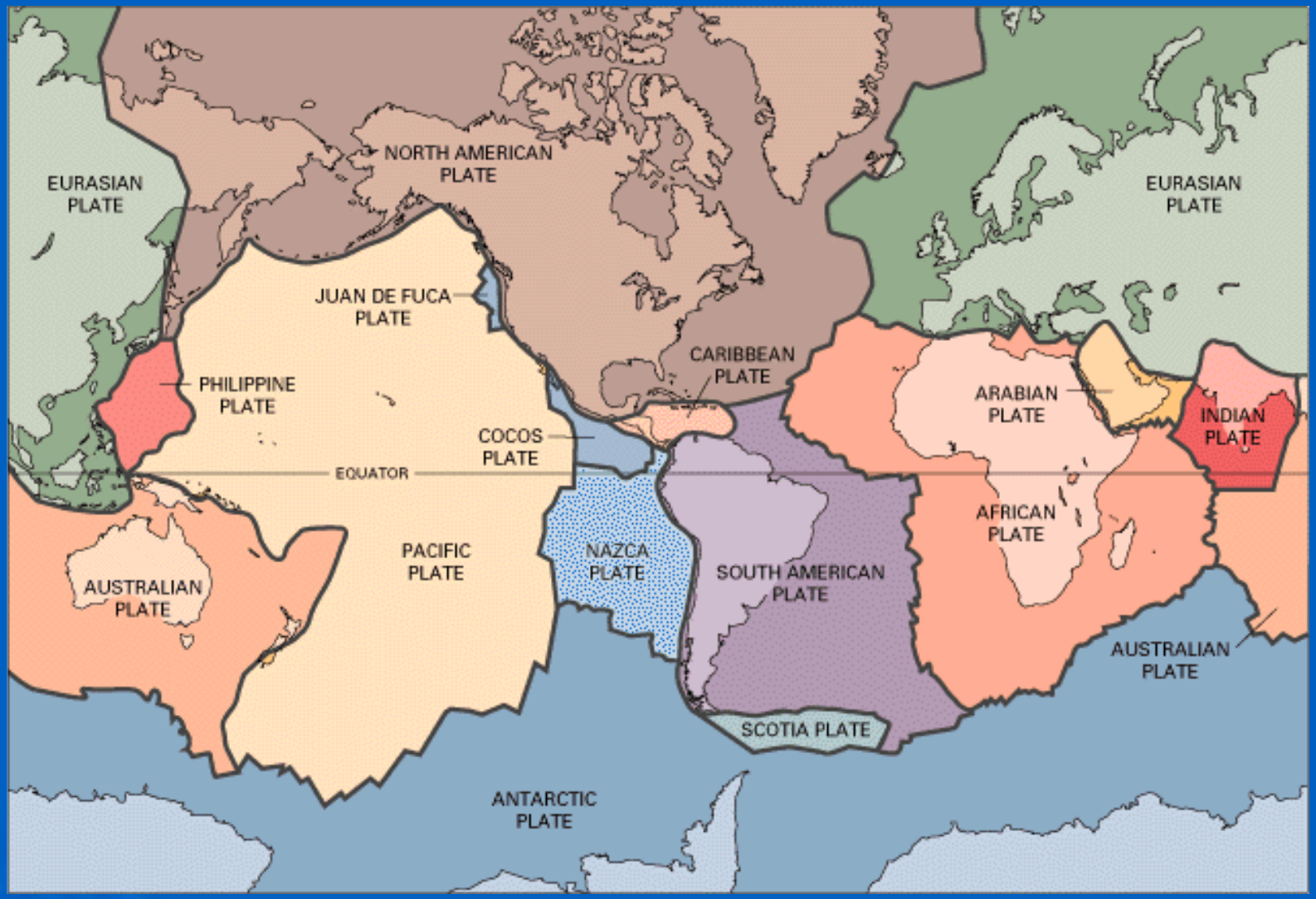

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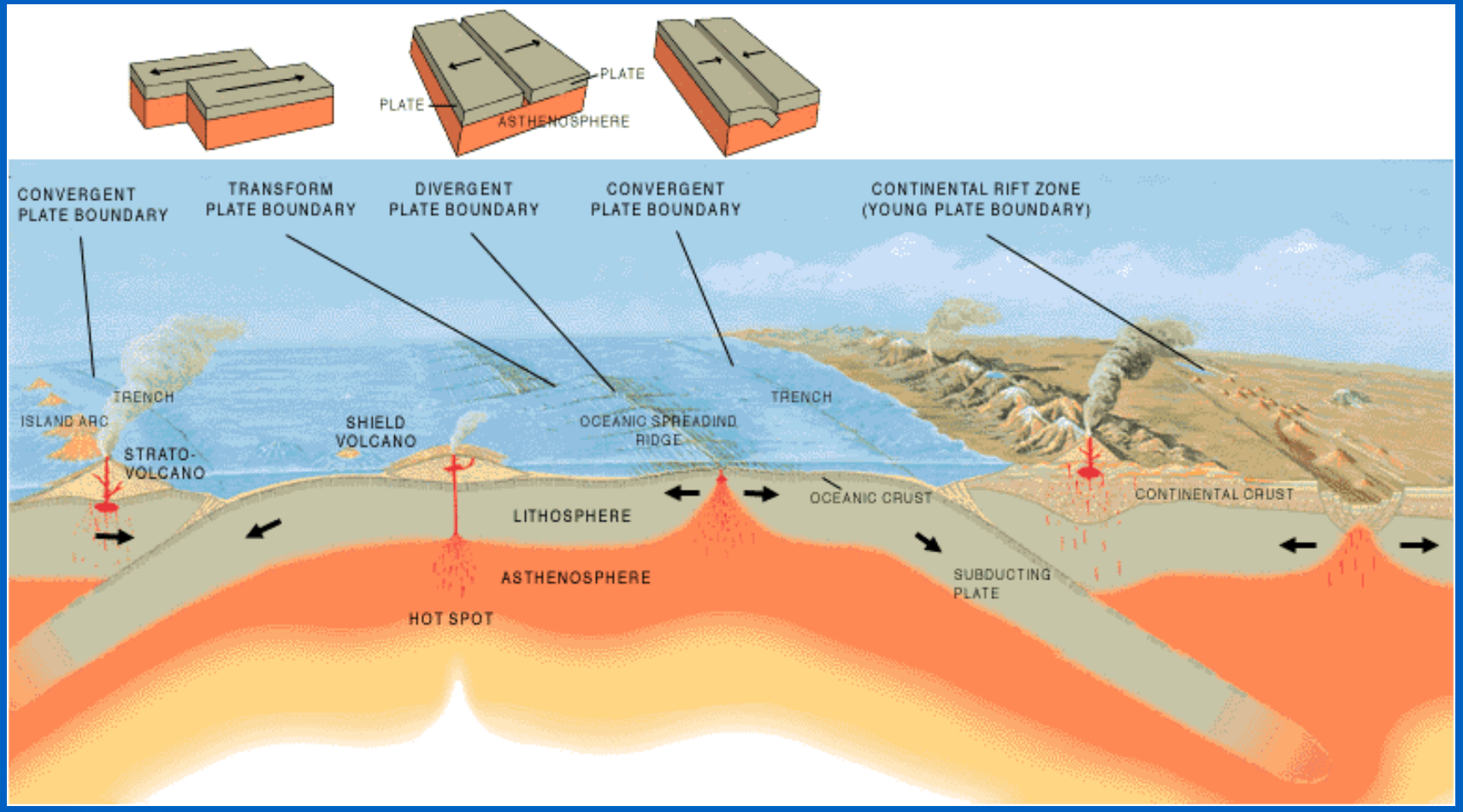
Plate Boundaries



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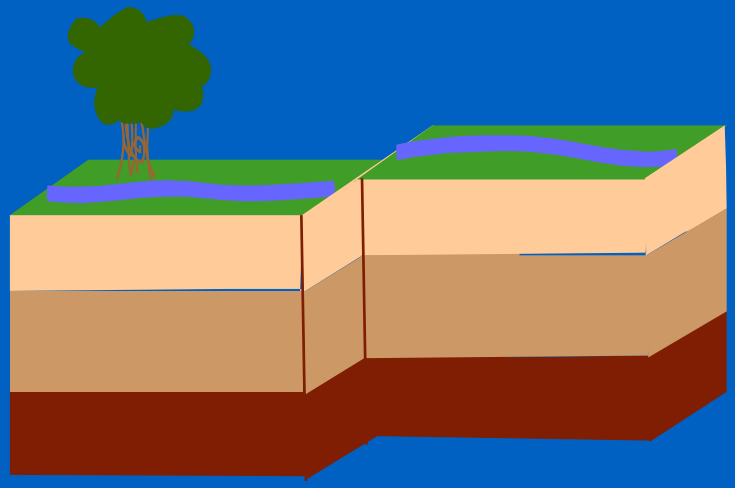
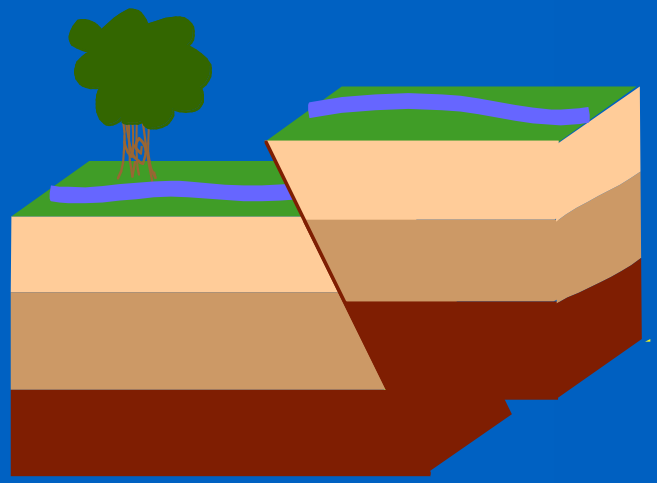
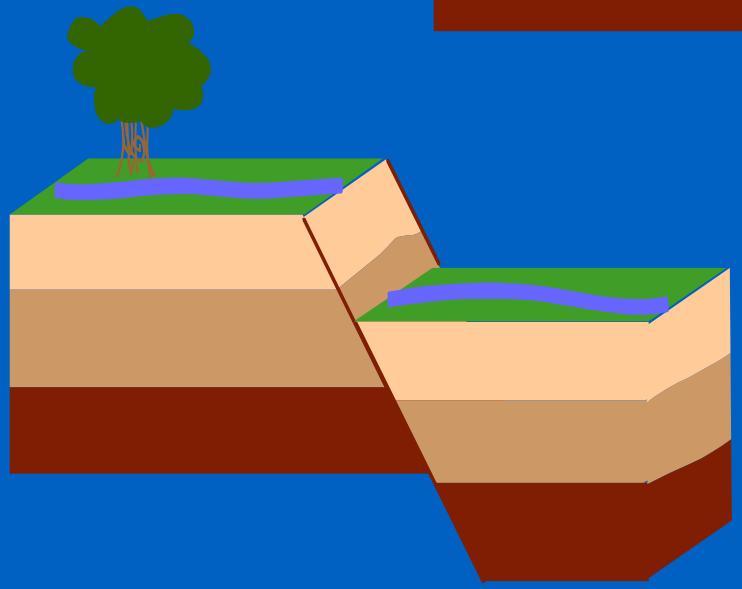
Three Types of Faults



Strike-Slip



Thrust



Normal

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Strike-slip Fault Example

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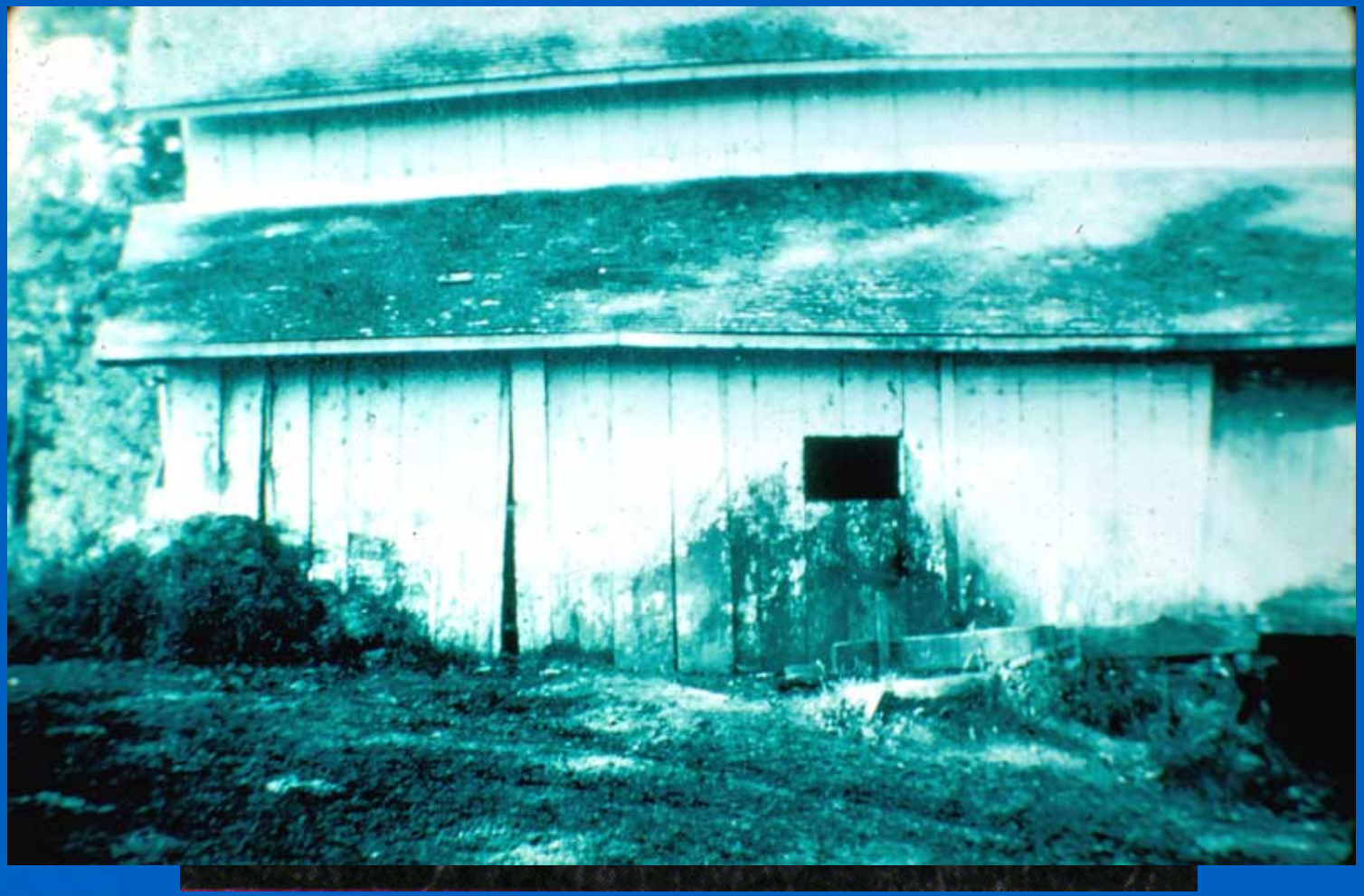
Strike-slip Fault Example



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1906 San Francisco Earthquake

Normal Fault Example

Dixie Valley-Fairview Peaks, Nevada earthquake
December 16, 1954

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Thrust Fault Example

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Thrust Fault Example

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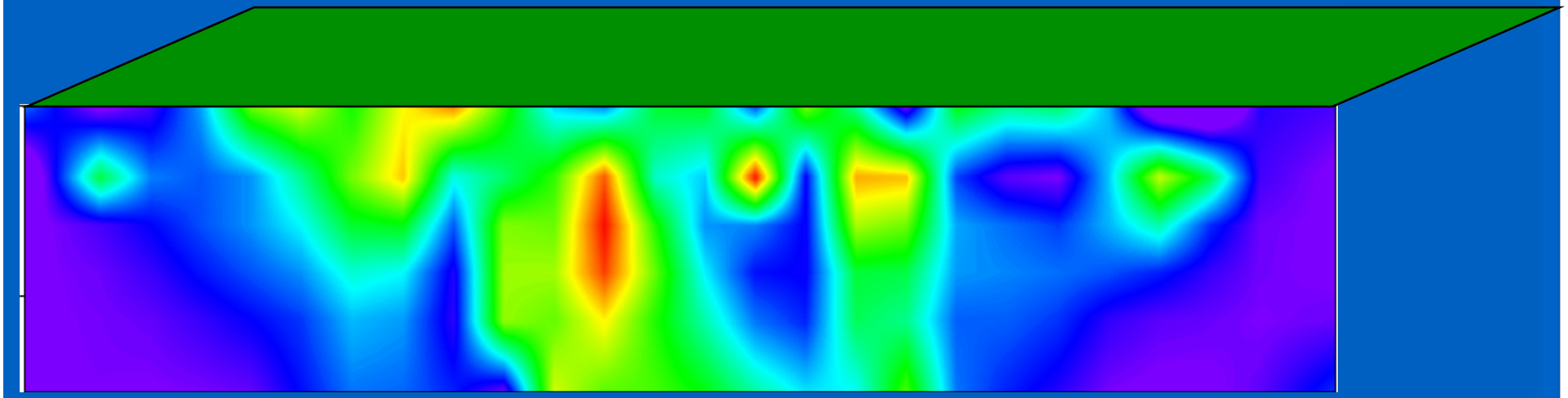
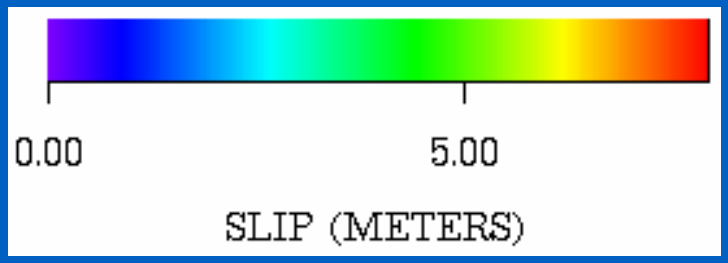
Rupture on a Fault

Total Slip in the M7.3 Landers Earthquake





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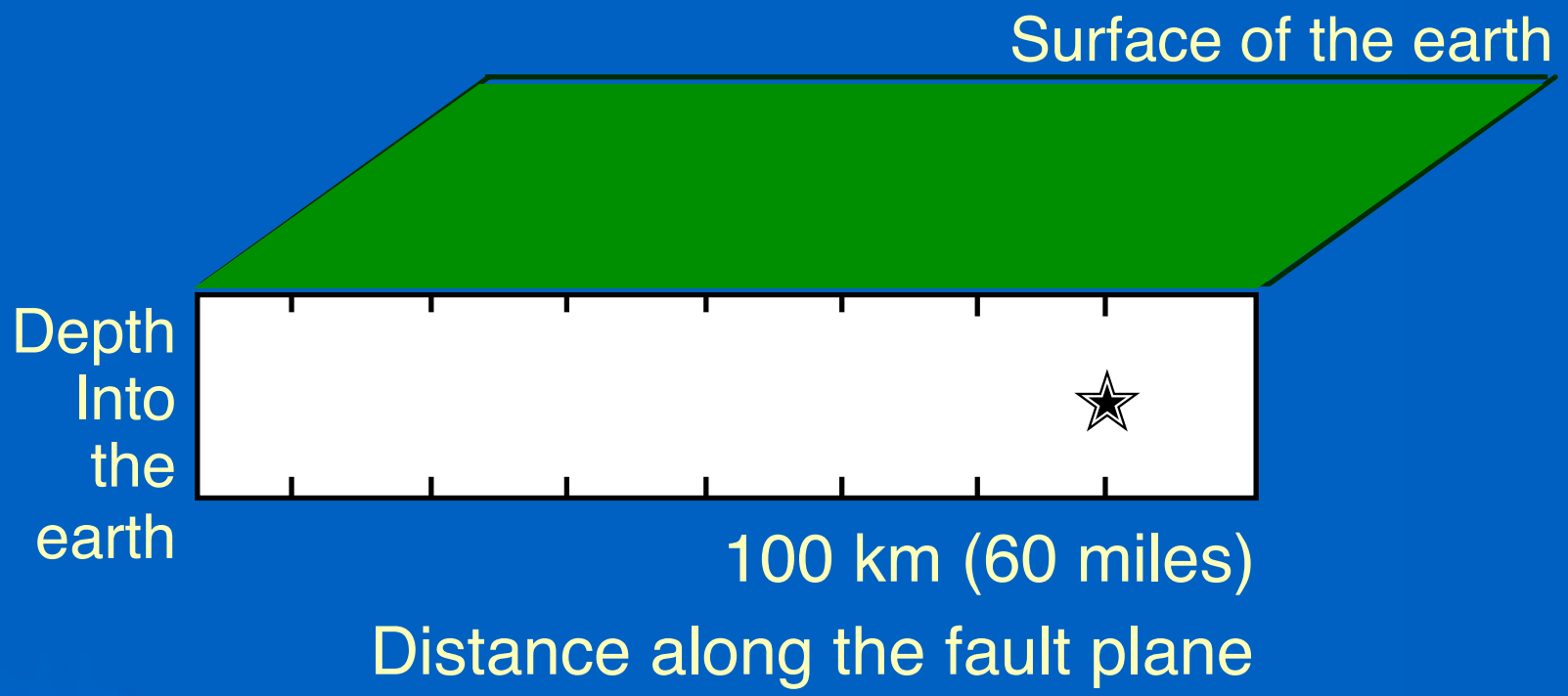
Slip on an earthquake fault

START



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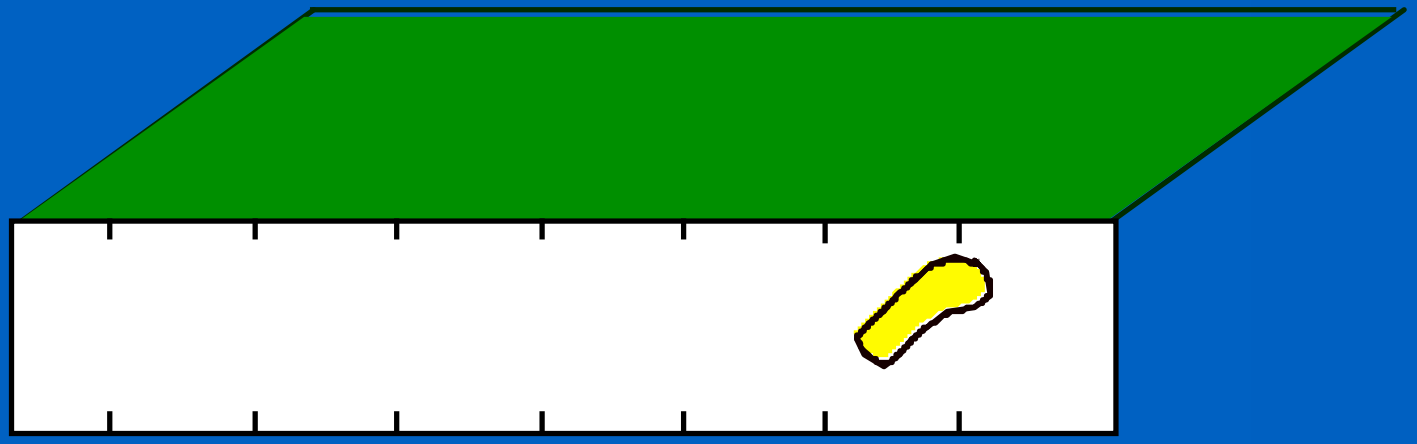
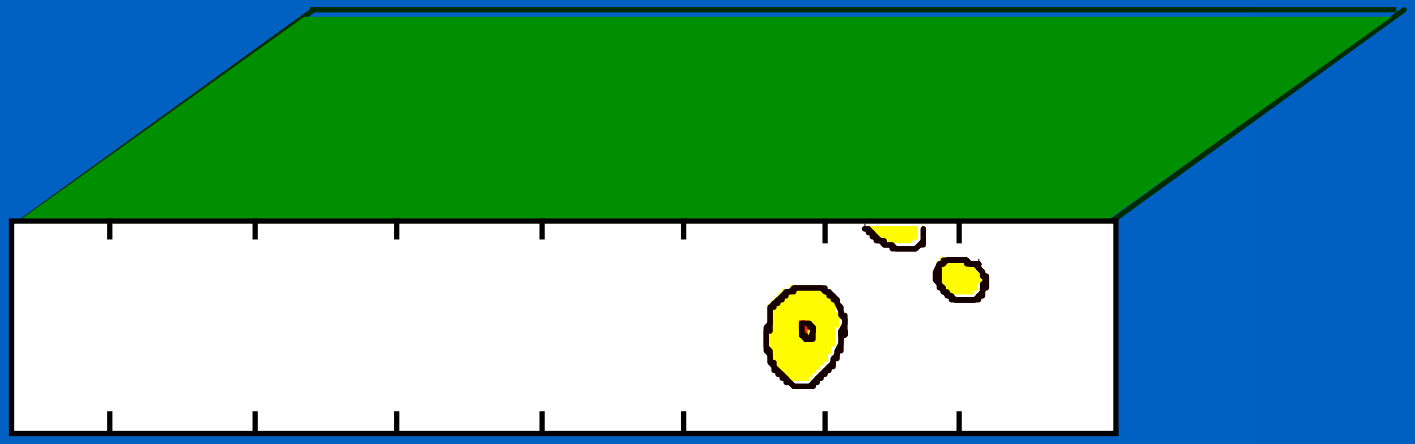
Slip on an earthquake fault
Second 2.0



USGS

Slip on an earthquake fault
Second 4.0



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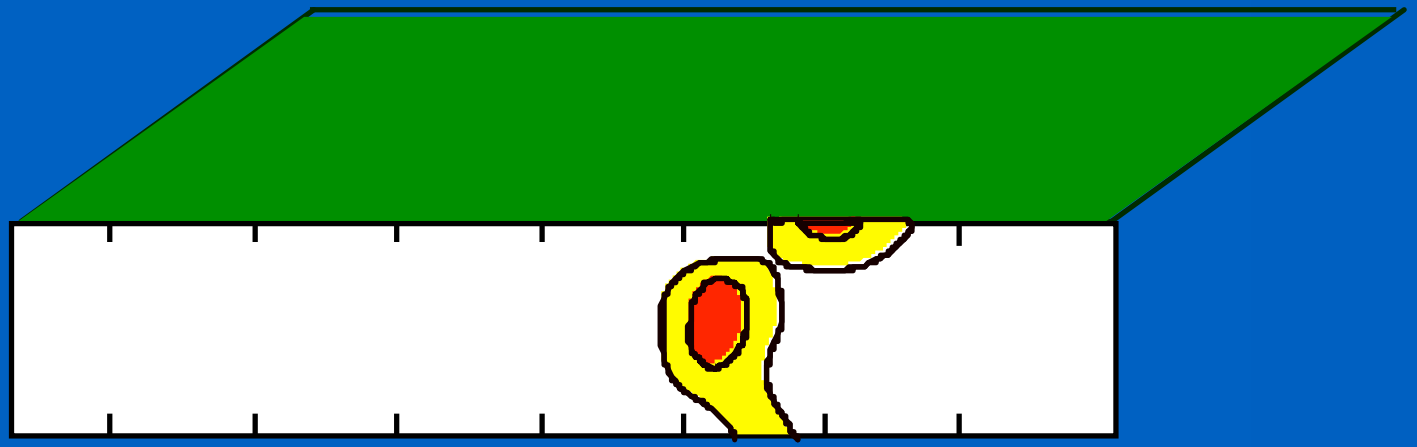
Slip on an earthquake fault
Second 6.0



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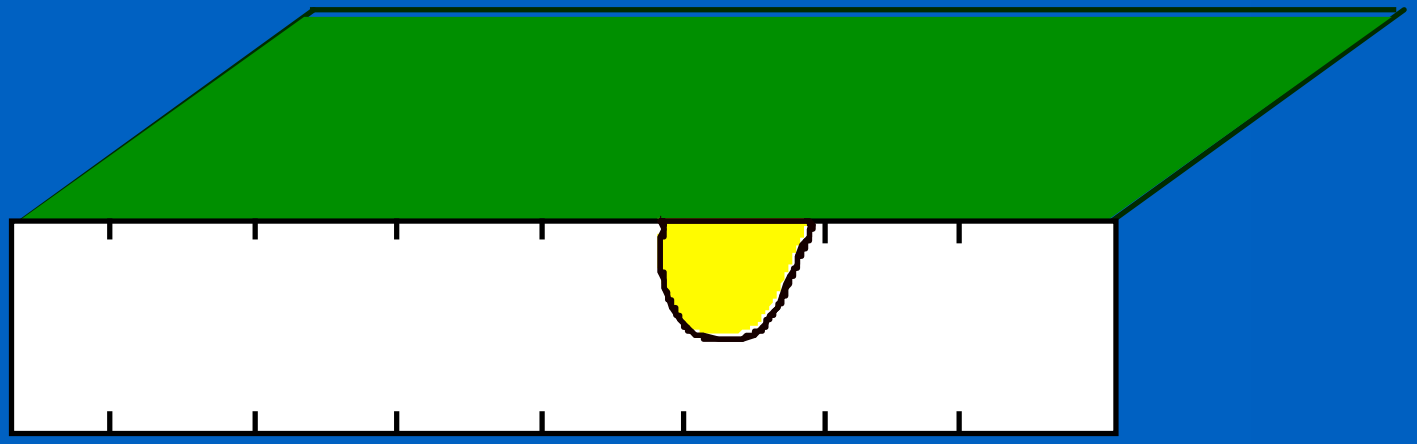
Slip on an earthquake fault
Second 8.0



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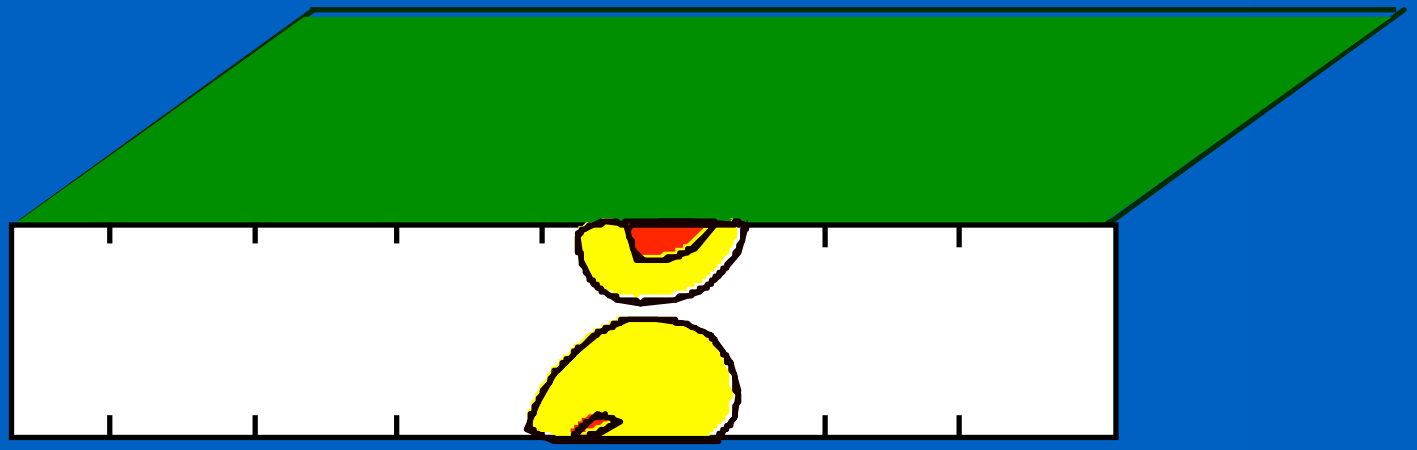
Slip on an earthquake fault
Second 10.0



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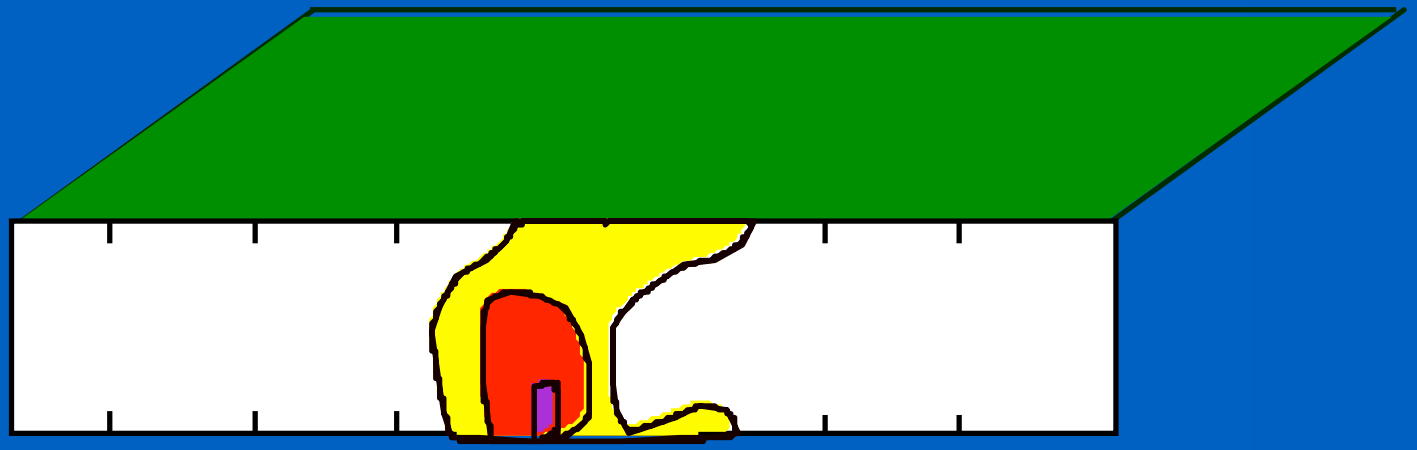
Slip on an earthquake fault
Second 12.0



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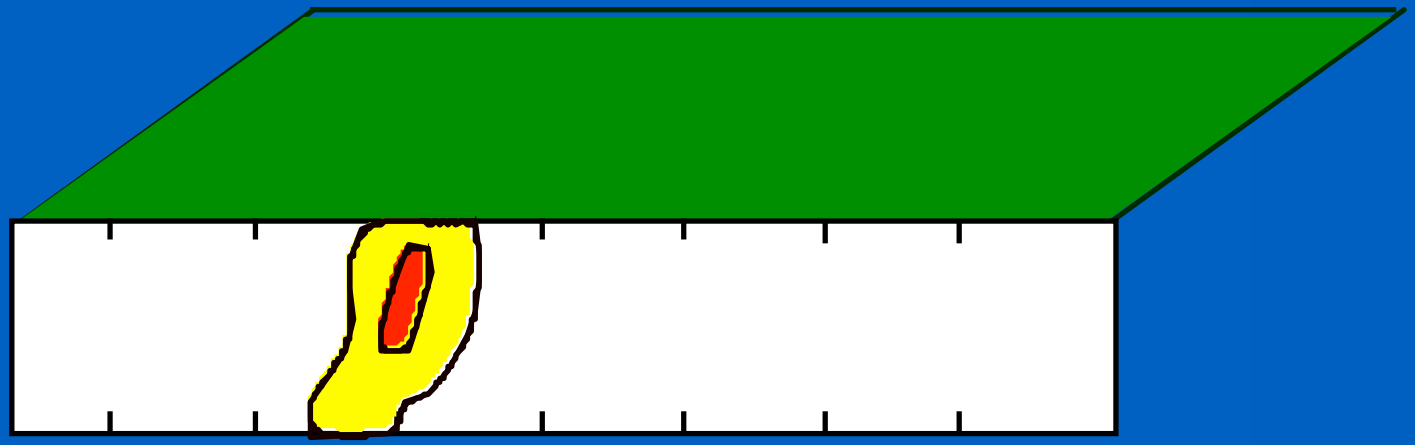
Slip on an earthquake fault
Second 14.0

USGS

Slip on an earthquake fault
Second 16.0



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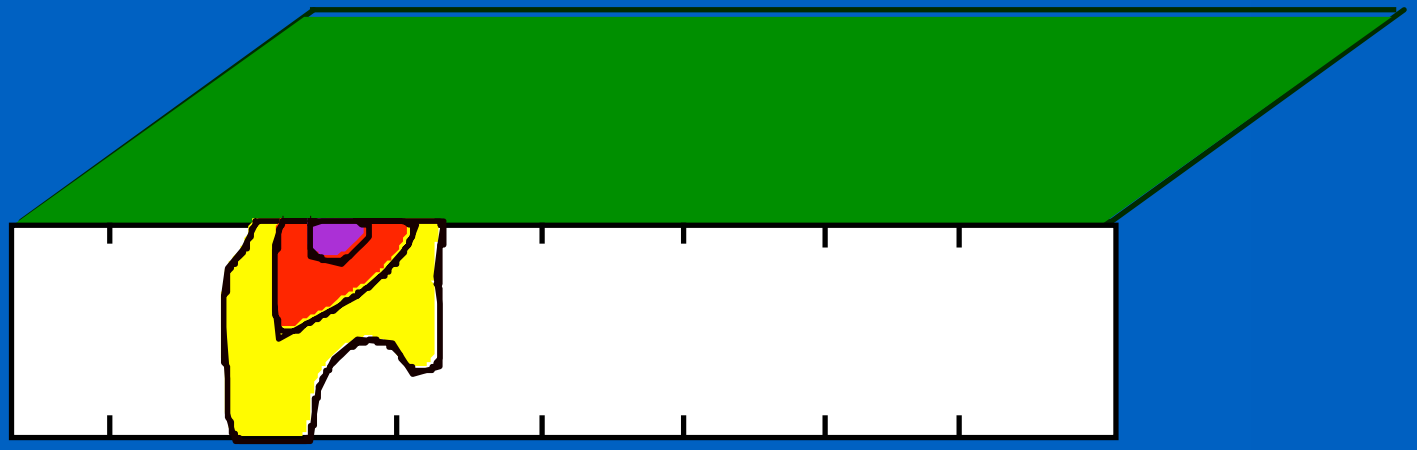
Slip on an earthquake fault
Second 18.0



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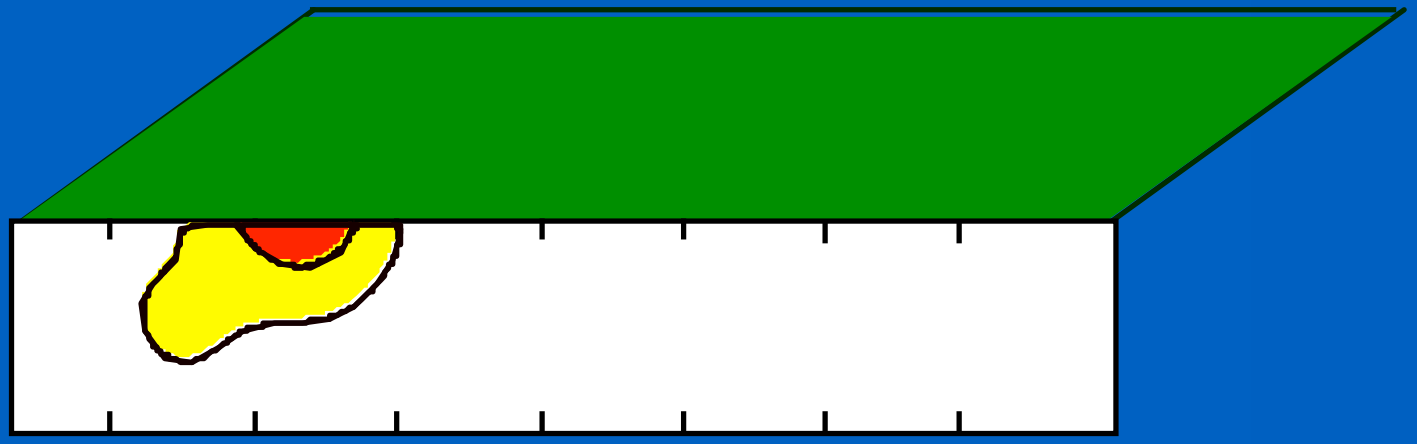
Slip on an earthquake fault
Second 20.0



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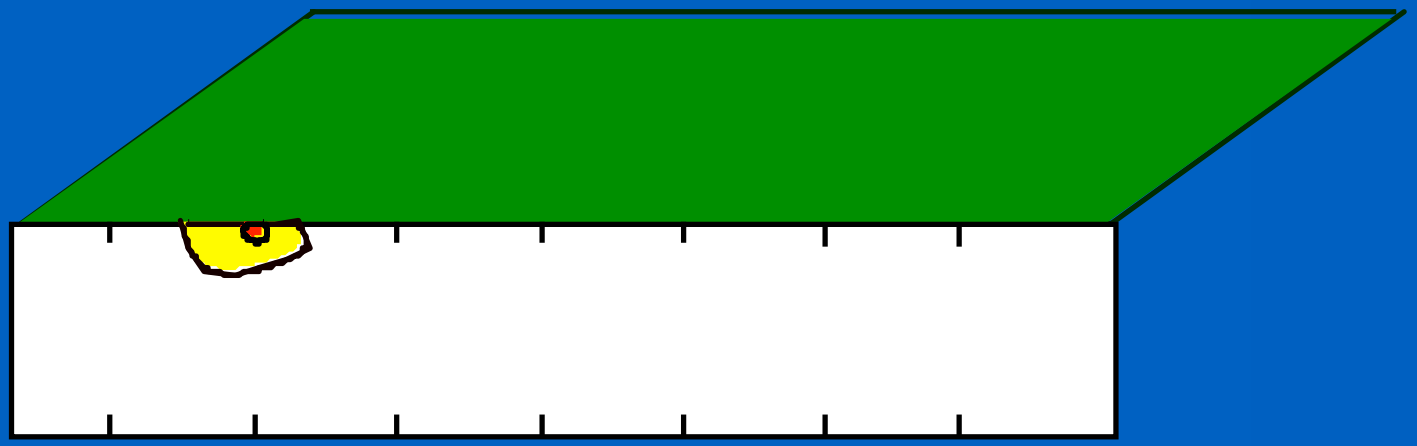
Slip on an earthquake fault
Second 22.0



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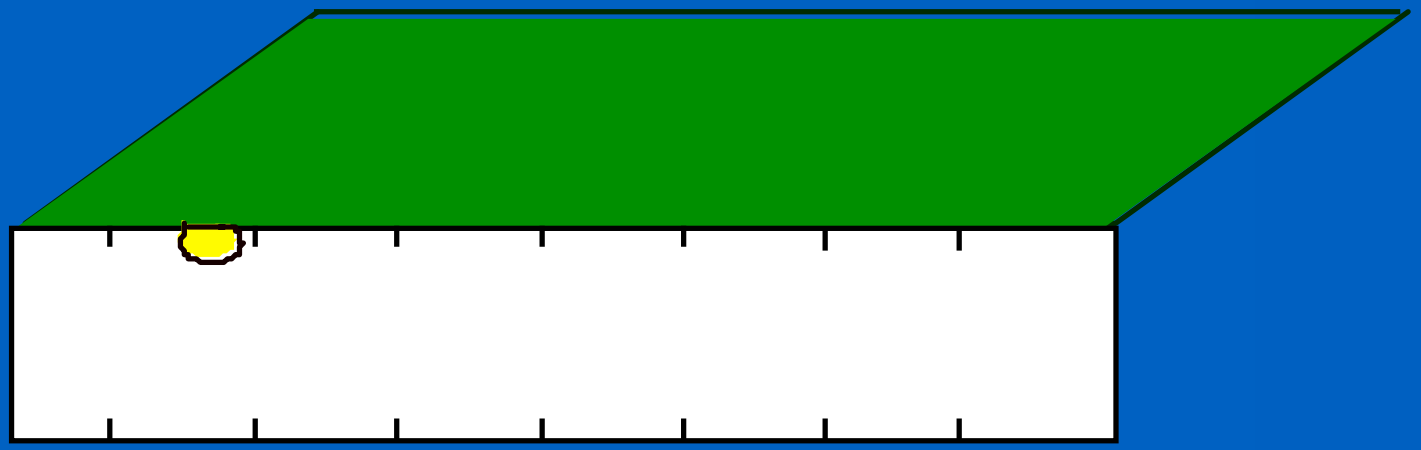
Slip on an earthquake fault
Second 24.0



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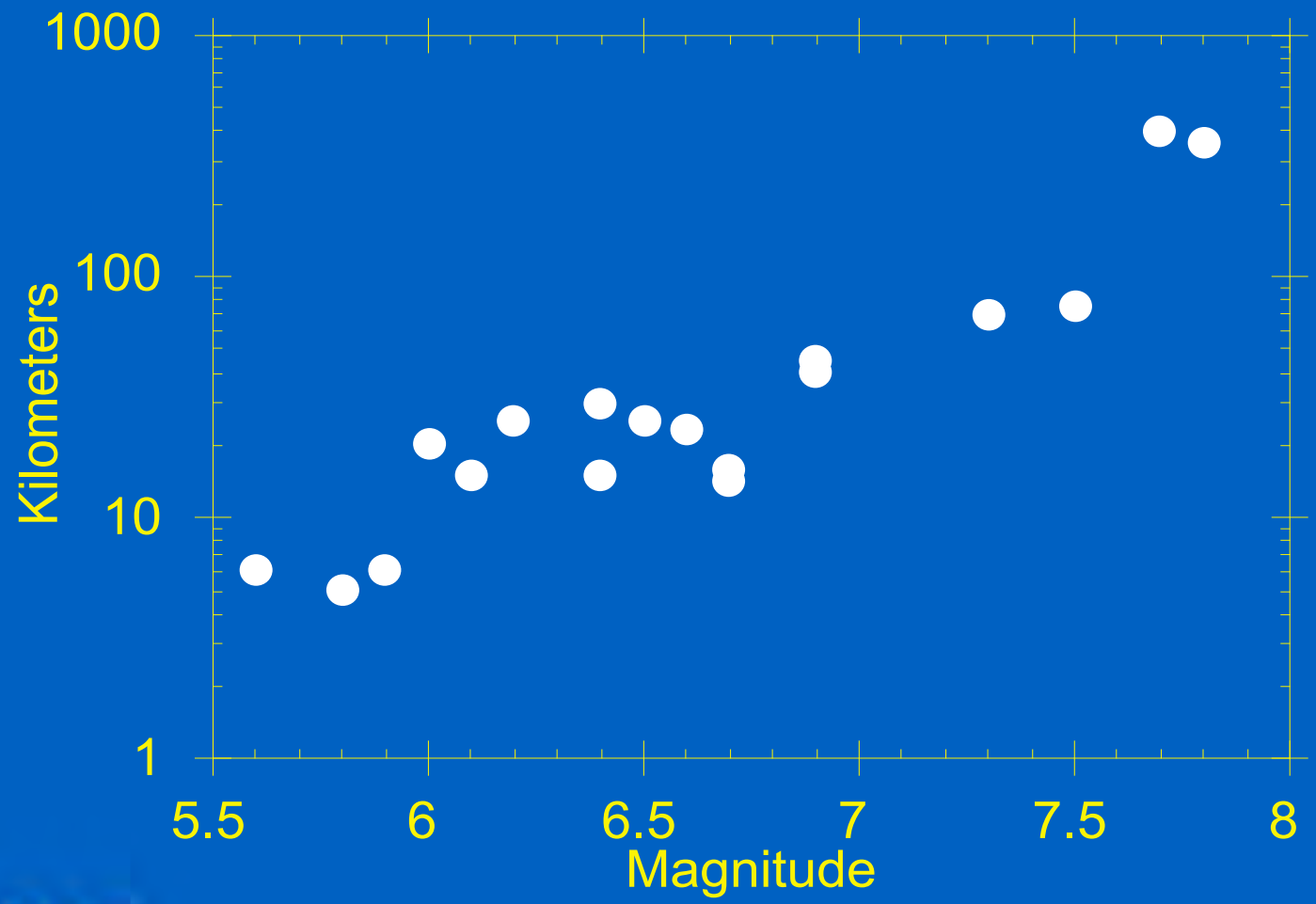
Bigger Faults Make Bigger Earthquakes



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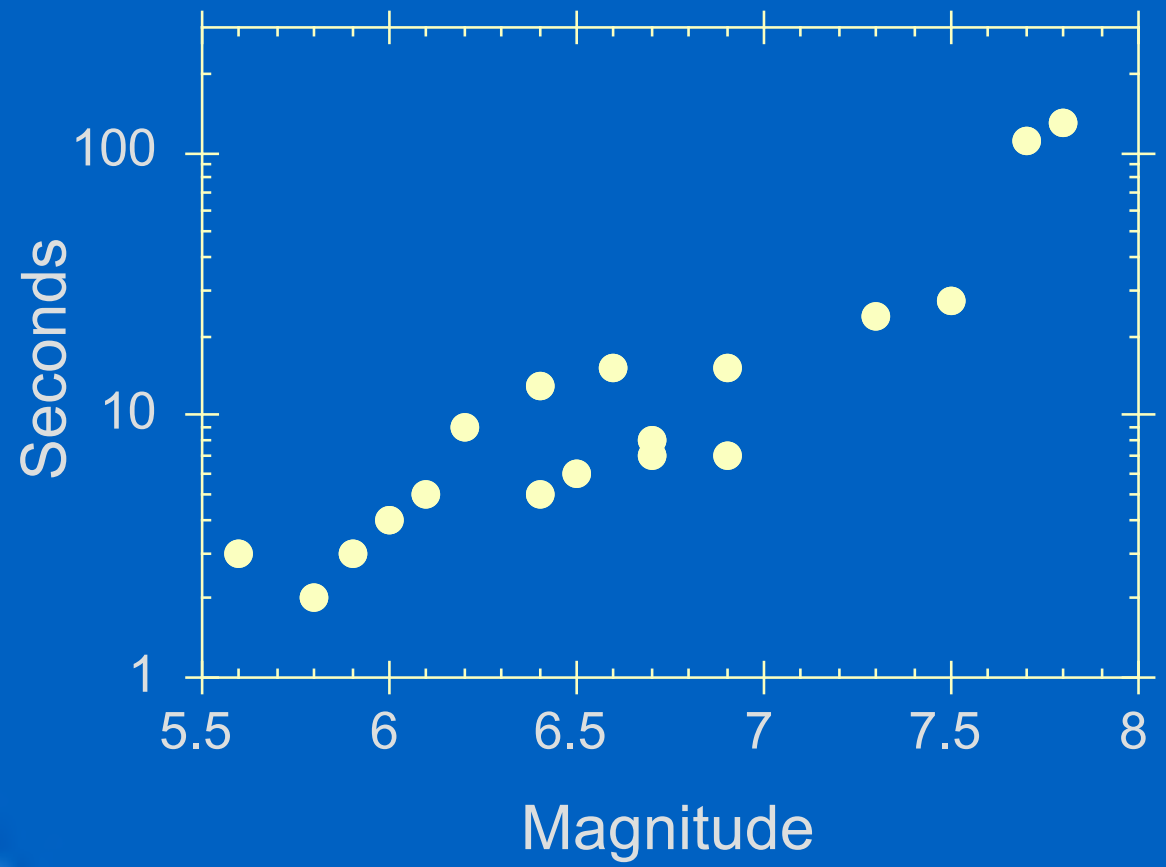
Bigger Earthquakes Last a Longer Time



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What Controls the Level of Shaking?

- **Magnitude**
  - More energy released
- **Distance**
  - Shaking decays with distance
- **Local soils**
  - amplify the shaking

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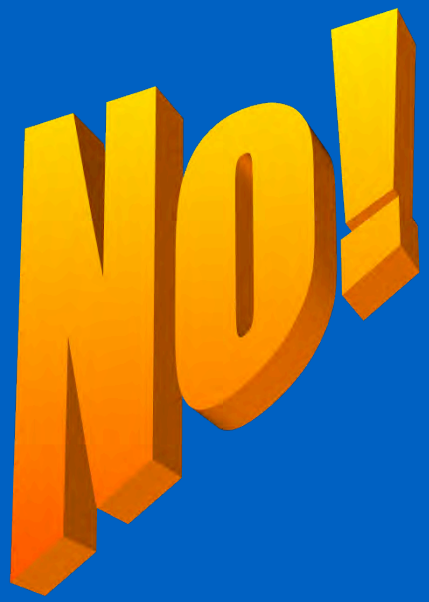
Is there such a thing as “Earthquake Weather”???



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Earthquake Effects - Ground Shaking

Earthquake Effects - Ground Shaking

Northridge, CA 1994

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Earthquake Effects - Ground Shaking

Loma Prieta, CA 1989

USGS

KGO-TV News ABC-7

Earthquake Effects - Ground Shaking

Kobe, Japan 1995

USGS

Earthquake Effects - Ground Shaking

USGS

Kobe, Japan 1995

Earthquake Effects - Surface Faulting

Landers, CA 1992

USGS

Earthquake Effects - Liquefaction

Source: National Geophysical Data Center

USGS

Niigata, Japan 1964

Earthquake Effects - Landslides

USGS

Turnagain Heights, Alaska,1964 (upper left inset);
Santa Cruz Mtns, California , 1989

Earthquake Effects - Fires

Loma Prieta, CA 1989

USGS

KGO-TV News ABC-7

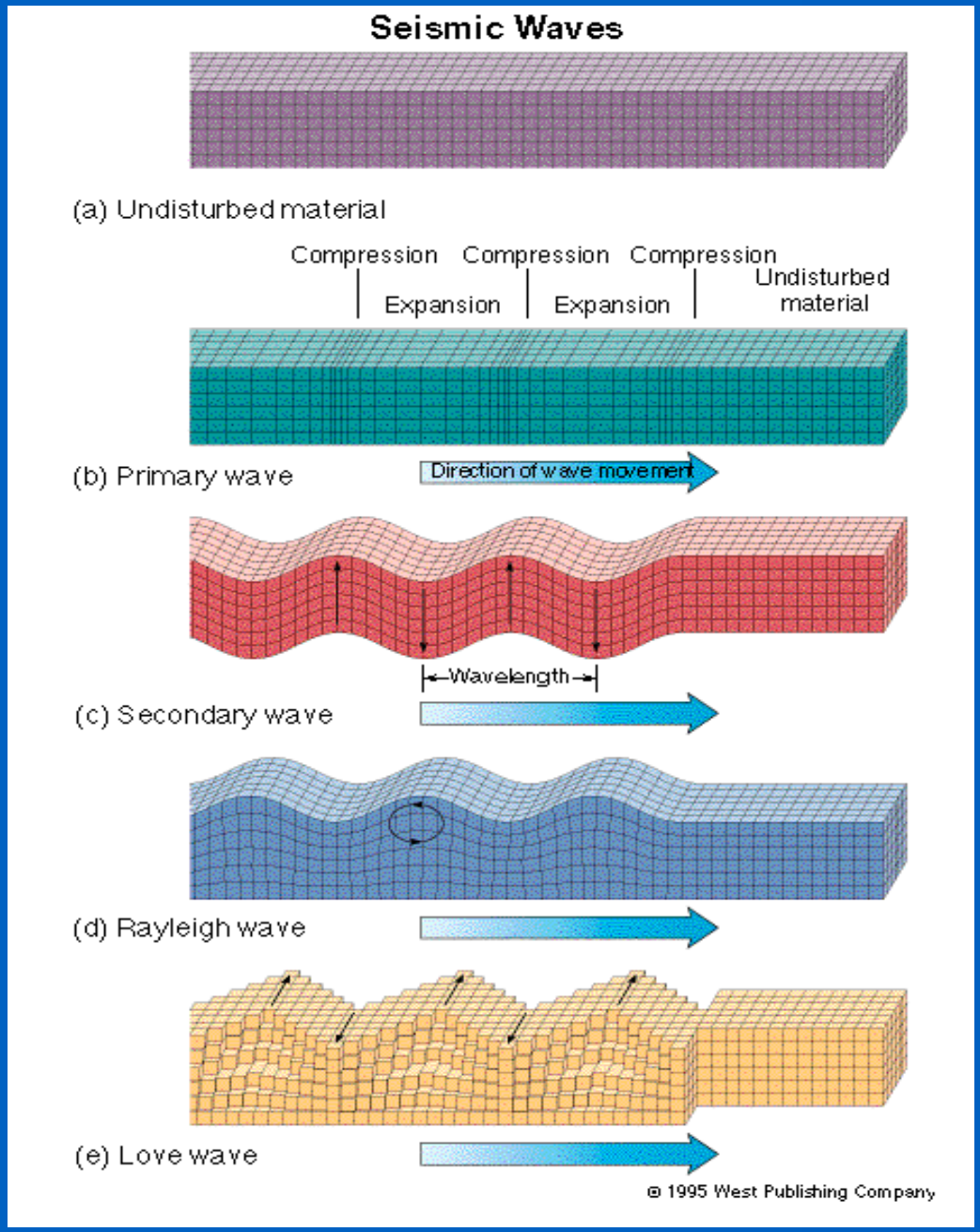
Earthquake Effects - Tsunamis

1957 Aleutian Tsunami

USGS

Photograph Credit: Henry Helbush. Source: National Geophysical Data Center

Seismic Waves



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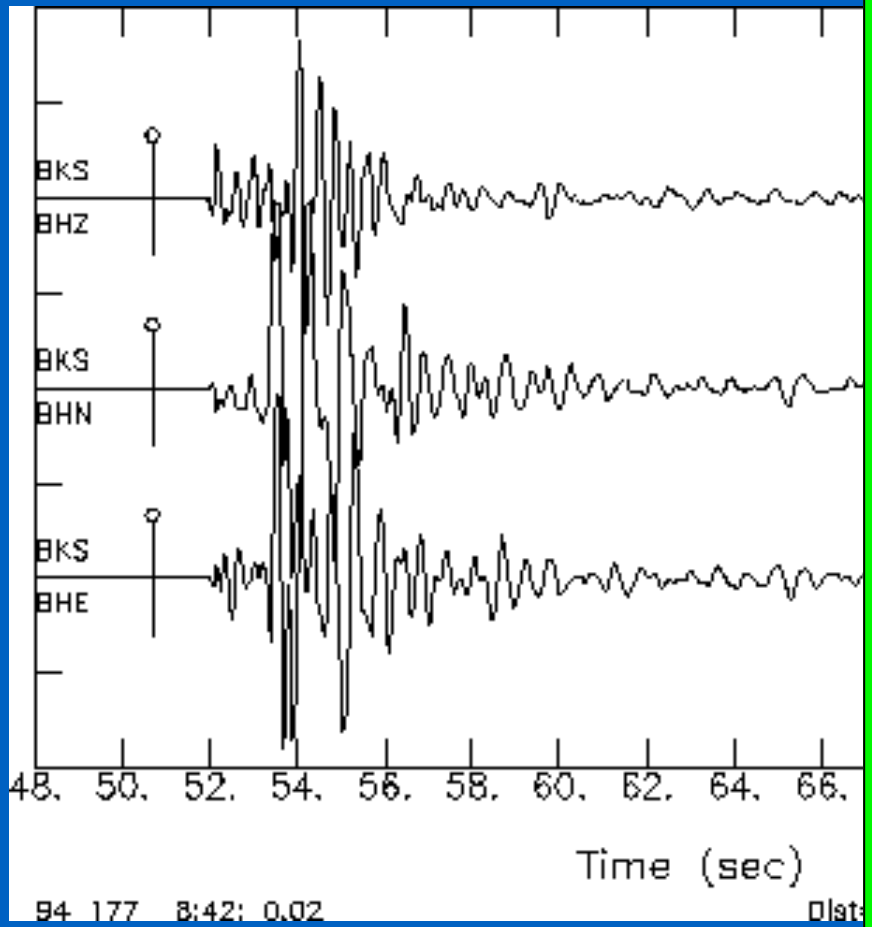
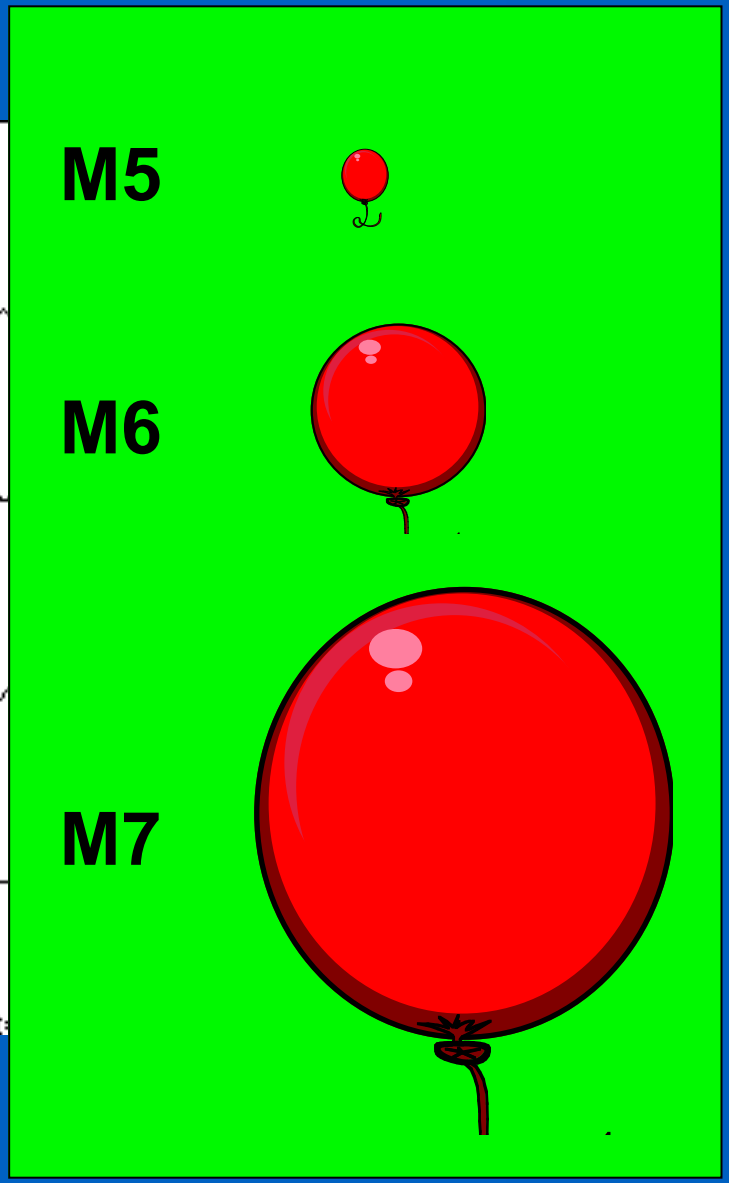
Earthquake Magnitude





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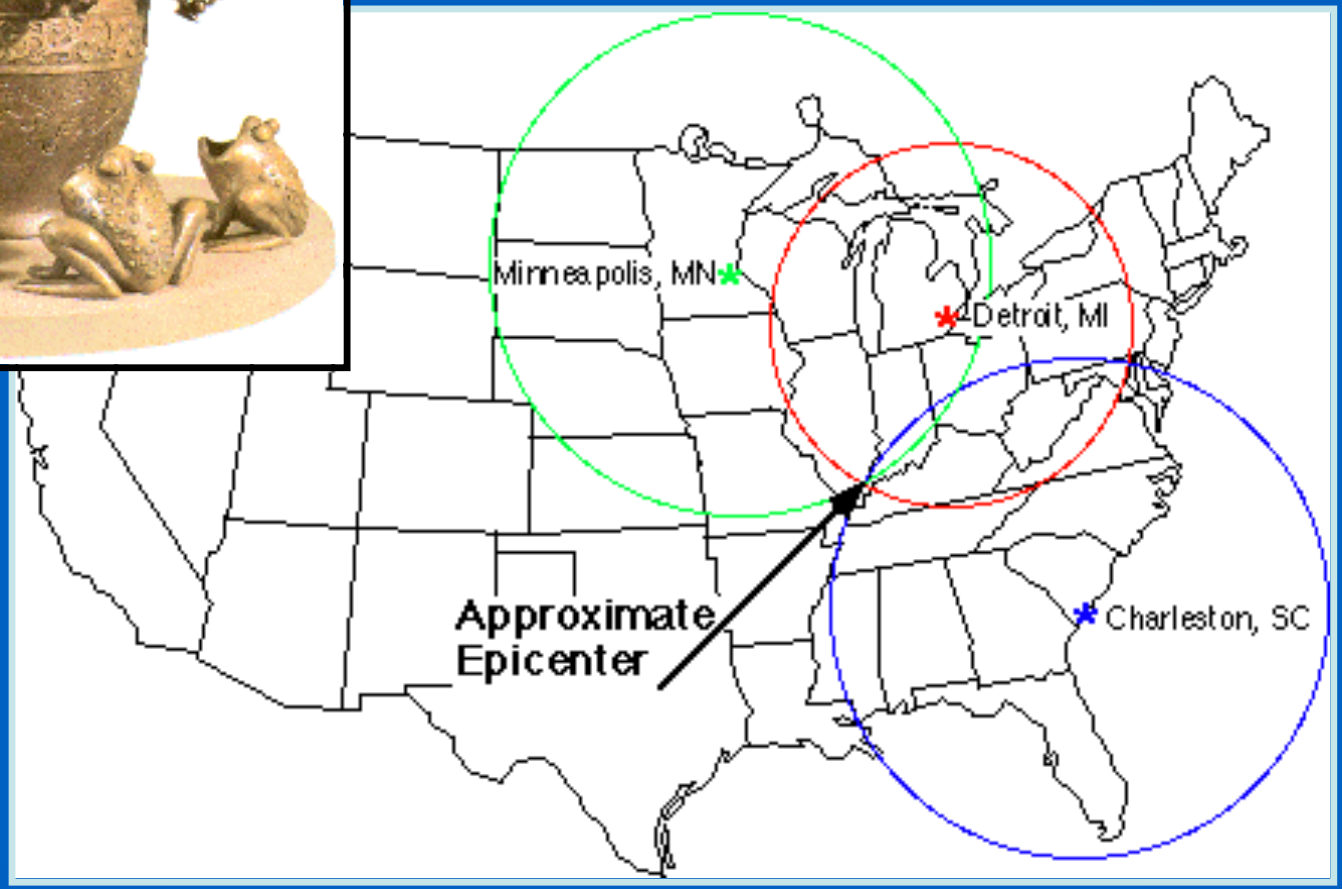
Earthquake Location



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The San Andreas Fault

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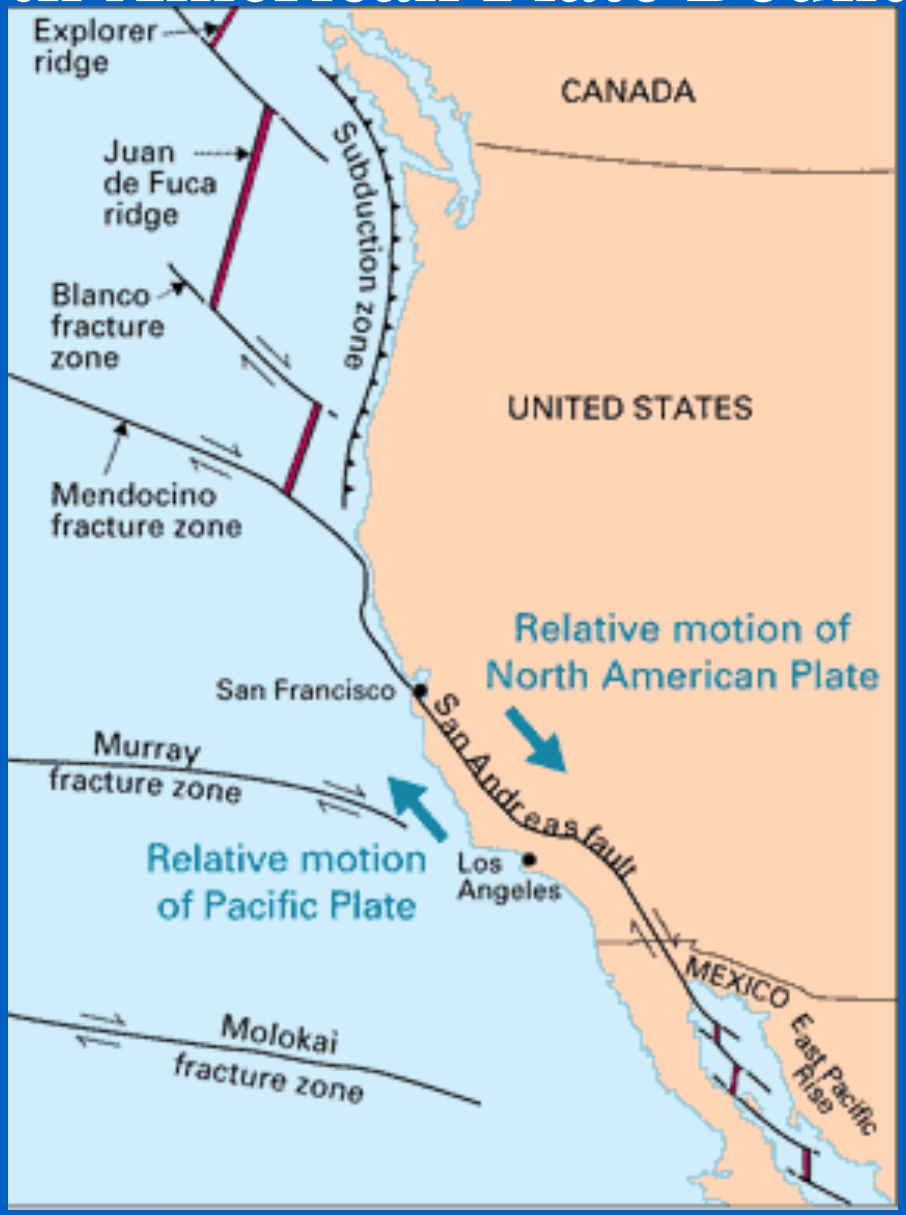
Pacific-North American Plate Boundary



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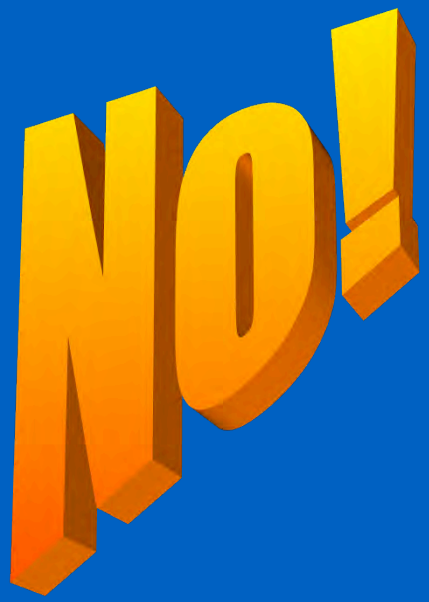
Will California eventually fall into the ocean???



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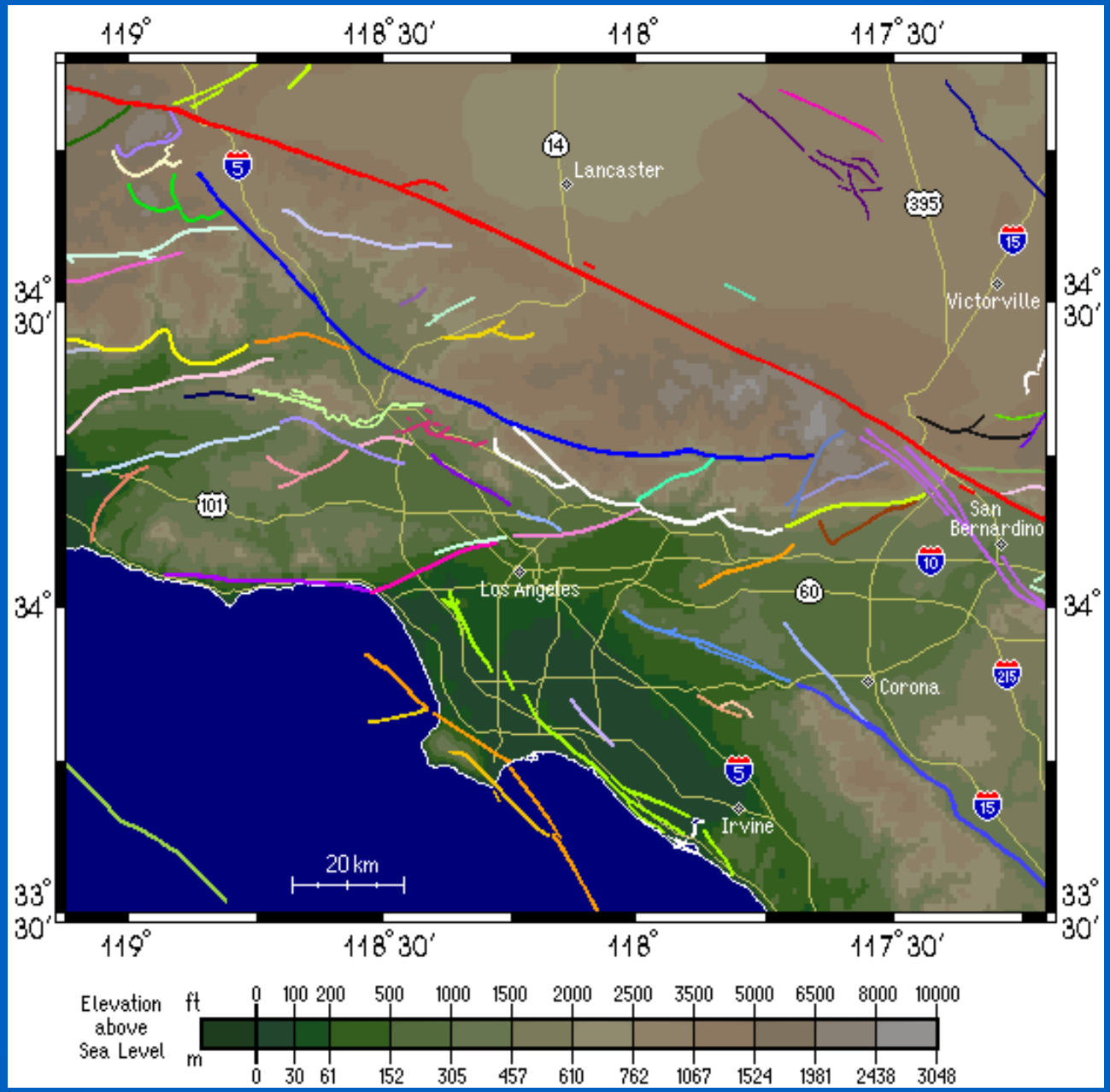
Faults of Southern California



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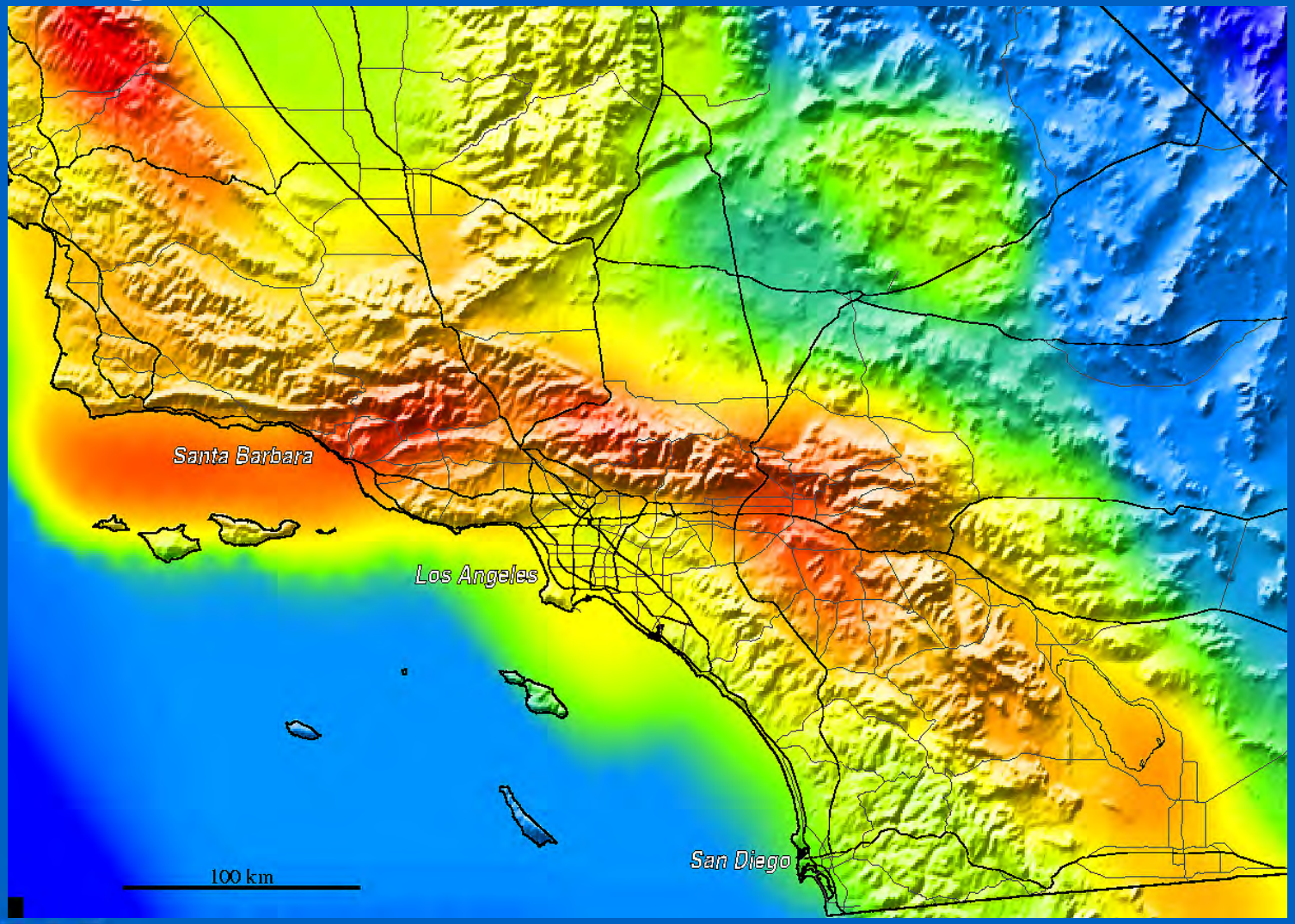
Source: SCEC Data Center

Shaking Hazard in Southern California



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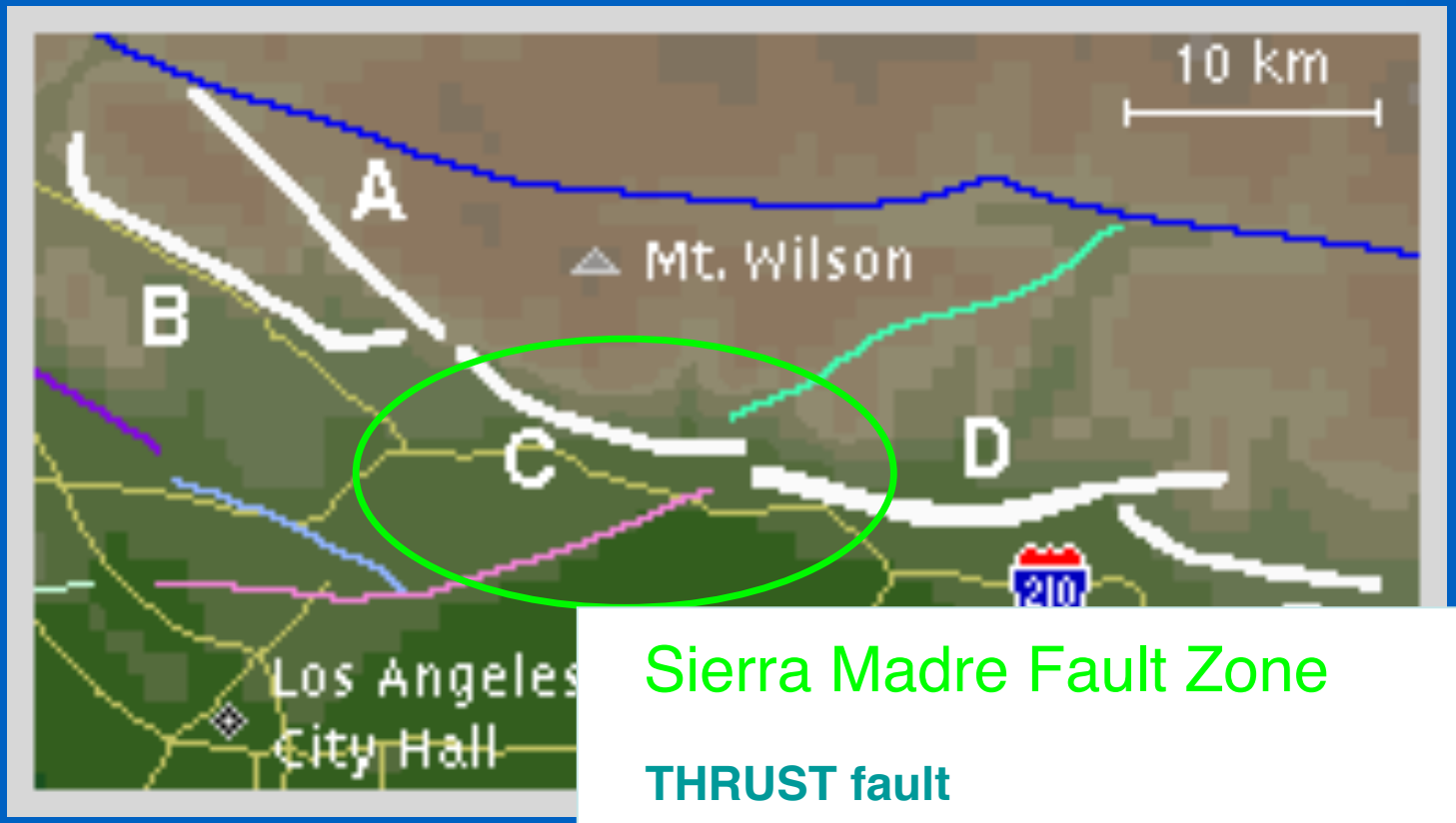
Faults in Our Local Area - Arcadia



Sierra Madre Fault Zone

THRUST fault
55 KM long
Last ruptured in last 10,000 YEARS
SLIP RATE: between **0.36 and 4 mm/yr**
PROBABLE MAGNITUDES: MW6.0 - 7.0 (?)
Dips to the north

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Faults in Our Local Area - Arcadia

Source: SCEC Data Center

USGS

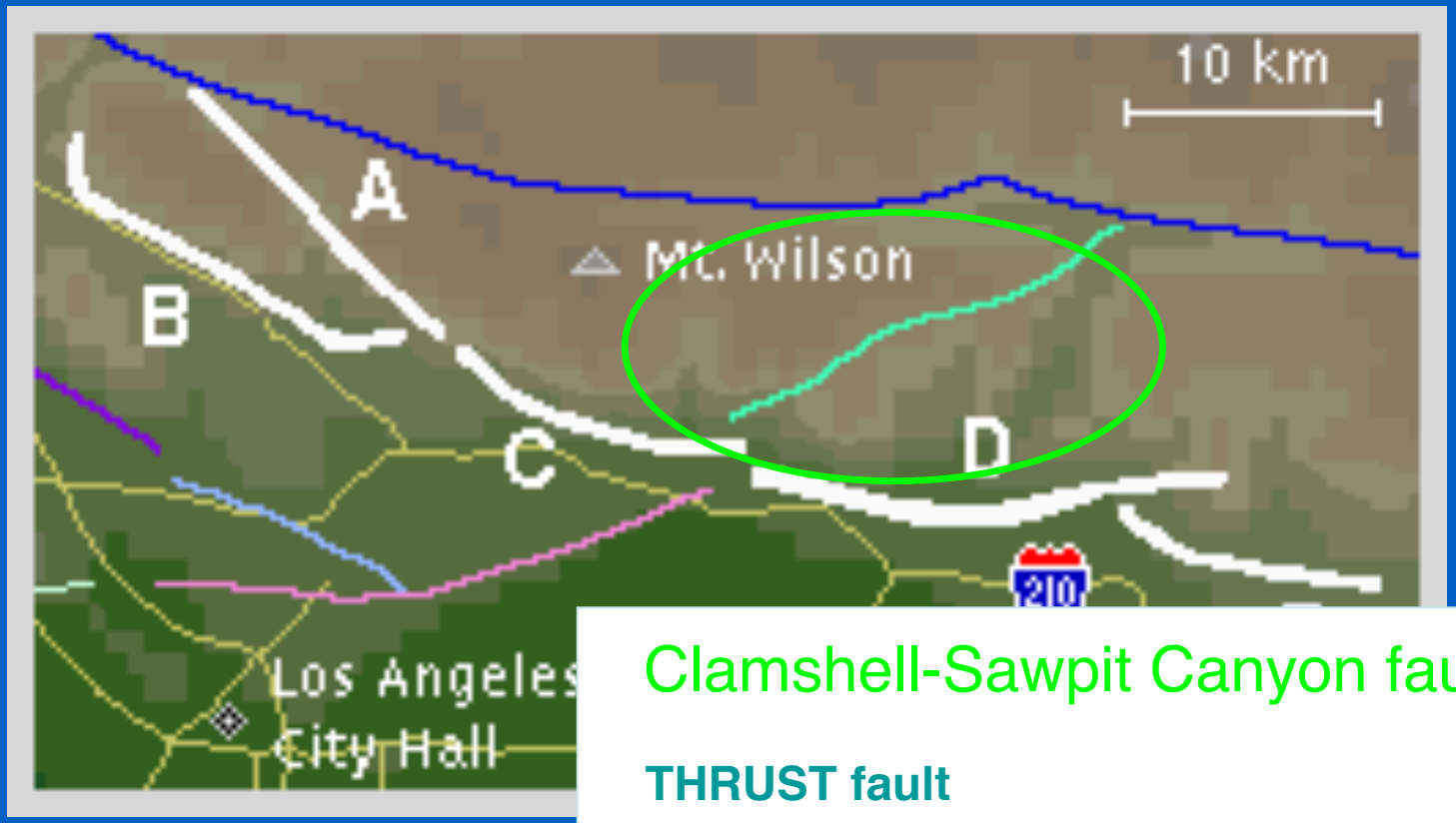
Raymond Fault

STRIKE-SLIP fault
26 KM long
Last ruptured in last 10,000 YEARS
SLIP RATE: between **0.10 and 0.22 mm/yr**

PROBABLE MAGNITUDES: MW6.0 - 7.0
Dips to the north

At least **eight** surface-rupturing events have occurred along this fault in the last 36,000 years

Faults in Our Local Area - Arcadia



Clamshell-Sawpit Canyon fault

THRUST fault
18 KM long
Last ruptured in last 1.6 million YEARS
SLIP RATE: ???
PROBABLE MAGNITUDES: ???
Dips to the north

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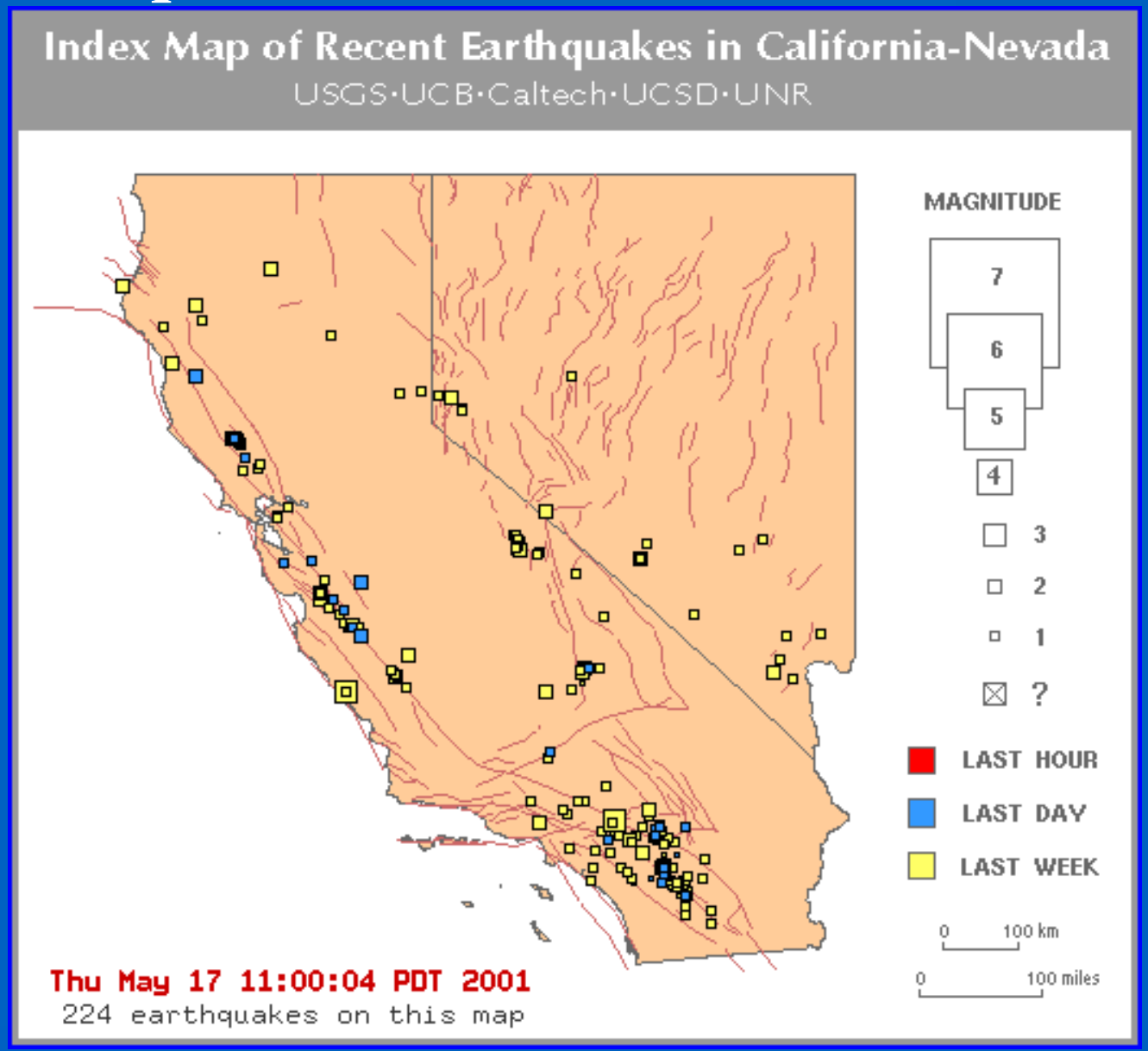
Real-time Earthquake Information



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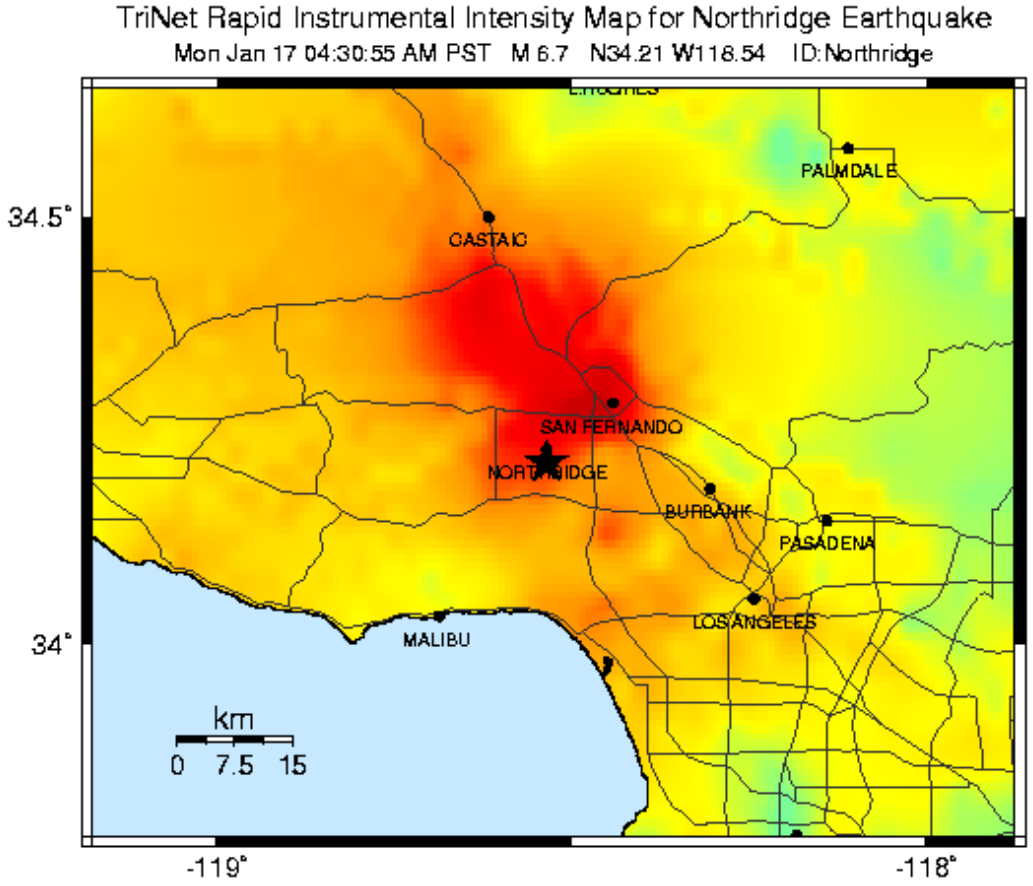
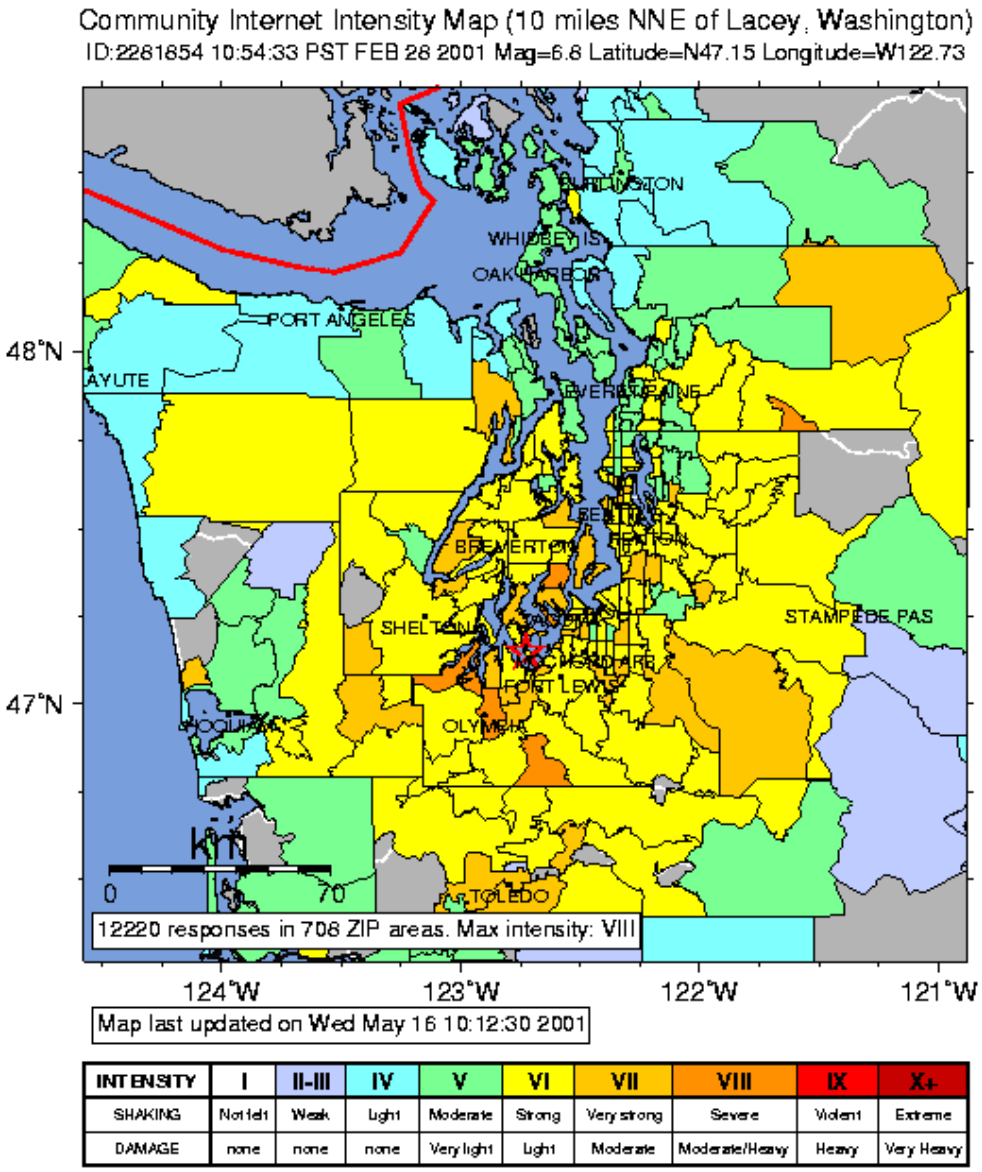
ShakeMaps



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Did You Feel It?

Community Internet Intensity Maps



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

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USGS Earthquake Hazards Program

U.S. Department of the Interior
U.S. Geological Survey

Where to go for more information:

http://pasadena.wr.usgs.gov/
http://earthquake.usgs.gov/

The End

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Faults in Our Local Area - La Canada

TYPE OF FAULTING: reverse

LENGTH: the zone is about 55 km long;
total length of main fault segments is about 75 km,
with each segment measuring roughly 15 km long

MOST RECENT SURFACE RUPTURE: Holocene,
10,000 years to present

SLIP RATE: between 0.36 and 4 mm/yr

INTERVAL BETWEEN SURFACE RUPTURES:
several thousand years (?)

PROBABLE MAGNITUDES: MW6.0 - 7.0 (?)

OTHER NOTES: This fault zone dips to the north.

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